Gender differences among talented adolescents:

Research studies by SMPY and CTY at The Johns Hopkins University

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Researchers at The Johns Hopkins University have been studying gender differences in aptitude and achievement among talented adolescents for approximately two decades. Since 1972, talent searches conducted under the auspices of the Study of Mathematically Precocious Youth (through 1979) and the Center for Talented Youth (since 1980) have revealed gender differences in performance on the mathematical portion of the Scholastic Aptitude Test (SAT-M) (Benbow & Stanley, 1983; Durden, Mills, & Barnett, 1990; Fox & Cohn, 1980). Concern about this phenomenon has stimulated considerable research in an attempt to shed light on the extent and causes of gender differences in aptitude and achievement, particularly in mathematics and science.

This paper presents an overview of gender differences in students' performance in the talent searches and academic programs sponsored by the Center for Talented Youth (CTY). In addition, other studies conducted by researchers at Johns Hopkins that have described or attempted to understand gender differences in the talent search population are summarized briefly.

Gender Differences in CTY Talent Searches

Seventh Grade Search. CTY's annual talent search invites 7th graders who score in the top three percent on an in-grade standardized test and who live in the appropriate region of the United States or abroad to take the Scholastic Aptitude Test (SAT). CTY's talent search region includes 19 states and the District of Columbia, plus an international component. Regional talent searches are also conducted in the United States by Duke University (see related paper by David Goldstein and Vicki B. Stocking in this volume), Northwestern University, and the University of Denver, and there are several state and local talent searches utilizing the Johns Hopkins model as well.

The SAT was designed to predict success in college among high school seniors. When used out-of-grade-level with 7th graders, this test is useful as an indicator of exceptional mathematical and/or verbal reasoning ability. The high ceiling on the more difficult SAT permits discrimination of ability among students who all perform well on in-grade achievement tests.

Although males were somewhat more represented in the early Johns Hopkins talent searches, the ratio has been approximately 50:50 since 1980 when CTY was created and the search expanded (see Figure 1). Talent searches held in 1991 and 1992, however, suggest a slight trend toward males outnumbering females again, with females in those searches representing 48.1% and 49.0% of the participants, respectively. CTY will continue to observe future searches to see whether this trend continues.

In spite of fairly equal participation by males and females, small but consistent gender differences in talent search mean scores on the SAT-M have been observed, with males

outperforming females on this test. Table 1 shows the mean scores of CTY talent search participants since 1980. Differences between the mean scores of males and females range from a low of 19 points (1991) to a high of 36 points (1984), always favoring males. This difference has been less in recent years than in earlier talent searches, however.

Table 1: Mean SAT Scores of Talent Search Participants

	SAT-M		SAT-V		TSWE	
Year	Female	Male	Female	Male	Female	Male
1980	390	421	377	373	40	38
1981	390	420	362	369	39	37
1982	380	410	361	361	39	37
1983	377	408	359	361	38	35
1984	375	411	352	358	38	36
1985	383	417	353	363	38	37
1986	384	416	354	359	39	36
1987	388	421	358	358	38	36
1988	384	415	349	355	38	36
1989	380	404	355	356	38	35
1990	394	422	354	353	39	37
1991	388	407	360	356	38	35
1992	400	423	354	350	38	36

In contrast to the gender differences in performance on the SAT-M, gender differences on the verbal portion of the SAT among talent search participants have been very small or non-existent, with the slight differences fluctuating between favoring males and females. Differences have also been very small on the Test of Standard Written English, a test of writing skills and English usage, though they favor females. Essentially, however, no meaningful gender differences in verbal ability have been observed in the CTY talent search population.

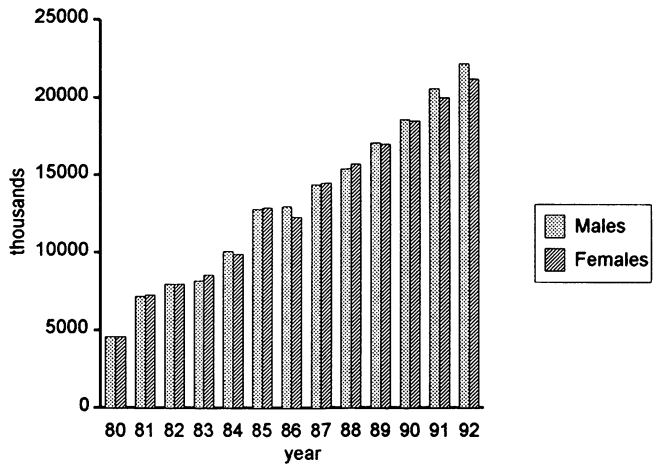

Figure 1: Total Participants (Talent search 1980-1992)

Gender Differences Among the Highest Scorers on SAT-M. Benbow and Stanley attracted considerable attention in 1983 when they published the ratios of male to female high scorers on SAT-M among 7th graders in the Johns Hopkins talent searches in 1980, 1981, and 1982. They reported ratios of approximately two males to every female scoring 500 or more, four males to every female scoring 600 or more, and 13 males to every female scoring 700 or more (Benbow & Stanley, 1983; see Table 2). CTY's more recent talent searches show considerable improvement in these male/female ratios since those early years; these results are also shown in Table 2. An analysis of gender differences on SAT-M from the talent searches held by CTY between 1984 and 1991 found that the ratio of males to females scoring 500 or above during those years was still almost 2:1. There was, however, a slight improvement at the 600 or above level; this ratio decreased from the previously reported 4 males to every female to a ratio of 3.4:1.

Table 2: Gender Differences Among High Scorers on SAT-M in Johns Hopkins Talent Searches

	1980 - 1982[1,3]			1984 - 1991[2,4]		
Score	Males	Females	M/F Ratio[5]	Males	Females	M/F Ratio[5]
500 or above	3,618	1,707	2.1:1	20,569	10,528	1.9:1
600 or above	648	158	4.1:1	4,647	1,292	3.4:1
700 or above	113	9	12.6:1	622	108	5.7:1

[1]Data from Benbow and Stanley, 1983.
[2]Data from Barnett and Corazza, 1992.
[3]Total tested: 19,883 males, 19,937 females. Additional students tested for 700 or above distinction.
[4]Total tested: 122,185 males, 121,063 females.
[5]The M/F ratio was adjusted to compensate for the total number of males and females tested except for the 1980-82 700 or above ratio where total tested was unknown.

An even more dramatic change took place, however, during the years 1984 through 1991 at the 700 or above level; 5.7 males scored 700 or above for every female that reached that level, one-half the number reported by Benbow and Stanley in 1983. Of course, the proportion of total talent search participants who score at this level is very small, since these are extremely high scores. Nonetheless, it is encouraging to note that the proportion of students who score 700 or above on SAT-M before age 13 that is female is higher than was previously thought.

Young Students' Search. In 1992, CTY initiated a talent search for 5th and 6th graders using the Upper Level form of the Secondary School Admissions Test (SSAT). As in the 7th grade talent search, the purpose of choosing an above-grade-level form of the test was to discriminate among students who all perform well on in-grade tests. Norms for 8th and 9th grade students were used for comparison purposes. Of the 7,944 students who participated, males were somewhat more represented than females (54% compared to 46%). This contrasts with the more equal representation in the 7th grade search.

As in the 7th grade search, males outperformed females on the quantitative part of the test, though differences were small. Among 5th graders, the mean scores were 279 for females and 284 for males out of a possible total score of 350; among 6th graders they were 289 and 296, respectively. No gender differences were found on the verbal portion of the SSAT. Since this was the first year of this talent search, it will be important to observe trends over time. CTY also plans to observe the relationship between scores earned in the young students' talent search and later SAT scores obtained by the same students.

The School and College Abilities Test. In an attempt to identify precocious reasoning ability among students younger than 7th grade, CTY has also used the School and College Ability Test (SCAT). A study of gender differences among students in the 2nd through 6th grades in performance on an above-grade-level form of the SCAT found significant differences in mathematical ability favoring males ($p \leq .001$). At every grade level, the mean difference was at least one-third of a standard deviation. A closer examination of responses to items on the SCAT suggested gender differences according to mathematical subskills. Comparison of factor scores revealed no differences between males and females on tasks requiring students to identify whether enough information was provided in order to solve the problem. However, males outperformed females on problems that required students to apply algebraic rules or algorithms, as well as tasks where the understanding of mathematical concepts and number relationships was required (Mills, Ablard, & Stumpf, 1993).

Other Standardized Tests

In an attempt to characterize the magnitude and pattern of gender differences in performance on a variety of standardized tests, Julian Stanley and colleagues analyzed 86 nationally standardized aptitude and achievement tests (Stanley, Benbow, Brody, Dauber, & Lupkowski, 1991). The tests included the Differential Aptitude Tests (DAT) taken by students in the 8th through 12th grades, achievement and aptitude tests taken by high school students (including the SAT, Preliminary Scholastic Aptitude Test, American College Testing Program examination, Advanced Placement examinations, and College Board achievement tests), and the tests taken by college students in the United States for admission to the nation's graduate, medical, business, and law schools.

Except for the DAT, the results of which were based on a normative sample, all of the tests investigated the results for the total national population of test-takers during the years investigated; thus, sample sizes were generally exceptionally large. Except for the DAT again, most of the tests are optional and are taken for purposes of admission or earning credit for coursework completed. Students taking these tests are a fairly selective group of students who expect to perform reasonably well.

Males excelled most in mechanical reasoning, females in spelling; women were slightly ahead in language usage, clerical speed and accuracy, English composition, and knowledge of some foreign languages; men were higher in quantitative reasoning, as well as in political science, physics, European history, computer science, and chemistry. Thus, higher test performance by males than females was not limited to quantitative fields, as most previous studies had implied. Gender differences were consistent across tests and grade levels and appeared on achievement as well as aptitude tests. The pattern of greater differences at the upper levels of ability found in the talent searches was upheld on many of these tests, and differences in some areas were great enough to affect admission to selective colleges and universities.

CTY Academic Programs

Enrollment in Summer Programs. CTY conducts rigorous academic summer programs for highly capable students in grades 7 through 10. A separate program was offered for the first time during the summer of 1992 for high scorers from the young students' talent search and is now held every summer.

Eligibility requirements to attend the program for 7th graders and above are: for a math or science course a minimum score of 500 on SAT-M and a composite of SAT-M + SAT-V of at least 930; to enroll in a humanities course, students must score at least 430 on SAT-V and 35

on the Test of Standard Written English. Gender differences in performance on the SAT-M obviously result in gender differences in eligibility for summer programs.

For example, of 42,734 students who took the SAT in CTY's 1992 talent search, only slightly more males than females were eligible to enroll in CTY's summer program (10.6% versus 9.2%, respectively). However, the difference is more significant when one considers students eligible to enroll in a mathematics or science course; 6.8% of the males tested compared to only 3.9% of the females tested met CTY's eligibility requirements for these courses. Thus, gender differences on standardized tests may lead to additional differences in opportunities to participate in special educational programs. Differential participation in such programs by males and females may contribute to greater gender differences in behavior and achievement.

Choice of Programs. In addition to gender differences in the opportunity to enroll in a CTY mathematics or science course as a result of differences in performance on the SAT-M, differing interests may be contributing to gender differences in mathematics and science achievement. The students whose scores made them eligible to choose to take either a mathematics or science course or a humanities course in the 1989, 1990, and 1991 summer program were studied. Of the eligible males, 58% elected a math or science course compared to only 40% of the eligible females. Females were more likely to choose a humanities course (60% compared to 42% of the males; Mills, 1992a).

It is certainly appropriate for students to select a humanities course for which they are eligible. However, when we study gender differences in mathematics and science, it is important to note that any differences in achievement due to gender differences in aptitude and/or opportunity may be intensified by males and females preferring and choosing different learning experiences.

Achievement in Summer Programs. Gender differences have been assessed in terms of achievement in the mathematics courses in the CTY summer program. On entrance placement tests, females appear to be equally prepared. However, given an opportunity to proceed at their own pace, the males are more likely to move at a faster pace through the curriculum.

An analysis of mathematics achievement among the students who attended the CTY program in 1989, 1990, and 1991 found that the majority of students completed one course at a high level, including 65% of the females and 63% of the males. However, females were slightly more likely not to complete a full course (19% of females versus 14% of males), and the students who completed two or more courses were somewhat more likely to be male (22% of males versus 16% of females) (Mills, 1992a). Thus, there were subtle differences in mathematics achievement in the program. While one cannot rule out differences in ability and/or mathematics background as contributing factors, it is likely that motivation and/or self-confidence may be contributing to the amount of mathematics students complete in the three week summer program.

In CTY science classes, gender differences favoring males were found in post-test scores in CTY Physics classes. However, this was not the case in the biology or chemistry classes (Gustin & Corazza, in press).

Math/Science Credit/Placement. Studies have also been conducted on students' success in receiving credit and/or placement for courses taken in the CTY summer program when they return to school. In terms of requesting appropriate credit and placement: in math an equal percentage of males (80%) and females (83%) requested credit or placement, but in science there was a gender difference with 72% of males and only 59% of females initiating discussion about credit or placement. This discrepancy may relate to males' greater self confidence in their science abilities and willingness to accelerate into more advanced science courses.

With regard to receiving credit or placement: Of those who requested credit or placement in science, there were no statistically significant gender differences in terms of those who were granted it. Over 70% of science students (regardless of gender) who requested placement

received it, and 40% received credit. In math, however, although approximately 70% of each gender was awarded placement upon request, there was a gender difference in those awarded credit for math courses: Only 30% of females versus 40% of males who requested credit for math courses taken during the summer actually received it (Mills & Ablard, 1992).

Gender Differences in Personality Traits and Attitudes

Personality Studies. Mills (1992ab) studied gender differences in personality variables among CTY summer program participants and found that either a "thinking" or "feeling" cognitive/psychological style as measured by the Myers-Briggs Type Indicator (MBTI) was related to differences in ability and achievement. Academically talented males were more likely to be "thinking" types, more goal directed, and less concerned with the needs of others than academically talented females. "Thinking" females, however, like their male counterparts, had higher SAT-M scores, chose math/science courses in larger numbers, and achieved at higher levels once enrolled in a flexibly paced mathematics class than "feeling" females. Thus, "thinking" males and females were similar in aptitude and achievement, as well as on other personality variables. These findings suggest the possibility that temperament may contribute to one's developed abilities, and that personality, in particular a thinking or feeling cognitive style, may influence educational and career choices and one's persistence in pursuing goals. If so, it is possible that gender differences in the thinking-feeling domain may influence gender differences in behavioral outcomes. Additional studies are underway at CTY to clarify this relationship further.

Attitudes Toward Mathematics. Studies conducted at Johns Hopkins in the late 70's and early 80's found talent search females less confident in their mathematical ability than males, even when SAT-M scores were comparable. Males also responded more stereotypically to categorizing mathematics as a male domain. Among the females, those with high aptitude but low interest in mathematics exhibited less confidence in their mathematical abilities, depicted mathematics more stereotypically as male, and viewed math as less useful than those with greater mathematics interest (Fox, Brody & Tobin, 1982, 1985).

Recently, a study was conducted to investigate whether such differences still persist. Similar results were found among students who attended a CTY summer program during the summers of 1989 or 1990, all of whom had scored a minimum of 500 on the Scholastic Aptitude Test-Mathematics and a total of 930 on the verbal and mathematical portions combined. Males exhibited greater confidence in their mathematics ability, and reported math as more useful and more stereotypically a male domain than females. A subgroup of students who had selected a math or science course at CTY for at least two summers was studied as a high-math-interest group for gender differences. No differences were found for usefulness or confidence, suggesting that girls who chose to take math or science in the program are likely to exhibit as much confidence in their mathematical abilities and were as likely to view math as useful as their male counterparts (Mills, Brody, & Krug, in preparation). It is possible that a lack of confidence inhibits female participation in mathematics and science at advanced levels, and that females who have this confidence are more likely to persevere in the study of advanced mathematics and science.

Conclusion

Studies of talented adolescents conducted by researchers at Johns Hopkins document consistent gender differences on standardized tests of quantitative reasoning ability, as well as in other cognitive areas. Although such differences have not emerged on verbal reasoning tests, they were found in non-quantitative areas such as history and political science.

In measures of quantitative ability, males outperformed females on tests taken by students as young as 2nd grade through college students applying to graduate school. In the CTY talent search, some improvement in females' performance on the SAT-M compared to males' has been noted in recent years. In particular, among the highest scorers on SAT-M in the CTY talent searches, the ratio of males to females scoring at this level is considerably less than was evident in the talent searches conducted in 1980-82.

In addition to gender differences in test performance, the research summarized here suggests differences between males and females in educational opportunities, interest, motivation, self confidence, and personality traits that may contribute to differential achievement by males and females in mathematics and science. More work is needed to help us understand the interaction effect of these variables in determining the attitudes and behaviors of talented individuals.

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